<u>CLAIMS</u>

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1. A heat sink for electrical or electronic components comprising:

a heat spreader plate to which the components to be cooled are connected;

at least two heat conducting fins that are positioned substantially parallel to one another and which are connected substantially perpendicular to said heat spreader plate; and

highly porous heat conducting reticulated foam block that fills the space between parallel fins.

2. A heat sink of claim 1 wherein said fins and said foam blocks are connected to one surface of said heat spreader plate.

3. A heat sink of claim 1 wherein the fin height, ***b***, is determined by the relationship,

$$\boldsymbol{b} = 0.6498\sqrt{\frac{k_f \delta_f}{h}}$$

where,

k_f is the thermal conductivity of the selected fin material, Btu/ft s °F

δ_f is the fin thickness, ft

h is the convective heat transfer coefficient for the foam-filled space bounded by the fins and the spreader plate, Btu/ft^2 s °F, and where h is given by the formula,

$$h = 1.2704\left[\frac{n^{0.50}}{(1-\phi)^{0.25}}\right]\left(\frac{\rho^{0.50}k^{0.63}c_p^{0.37}}{\mu^{0.13}}\right)u_m^{0.50}$$

where,

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n is the linear density of the foam material, pores per ft

ϕ is the foam porosity expressed as a fraction

ρ is the density of the flowing fluid, lb_m/ft^3

k is the thermal conductivity of the flowing fluid, Btu/ft s ^oF

c_p is the isobaric specific heat of the flowing fluid, Btu/lb_m ^oF

μ is the dynamic viscosity of the flowing fluid, lb_m/ft s

u_m is the mean velocity of the flowing fluid, ft/s

4. A heat sink of claim 1 wherein the fin spacing, ***a***, is determined by the relationship,

$$\boldsymbol{a} = \Phi\delta$$

where,

Φ is between 1 to 6

δ, ft, is determined by the relation,

$$\delta = 7.32\sqrt{\frac{kc}{\rho c_p u_m}}$$

where,

c is the selected fin length in the flow direction, ft

k is the thermal conductivity of the flowing fluid, Btu/ft s ^oF

ρ is the density of the flowing fluid lb_m/ft^3

c_p is the isobaric specific heat of the flowing fluid, $Btu/lb_m{}^oF$

u_m is the mean velocity of the flowing fluid, ft/s.

5. A heat sink of claim 1 wherein said heat spreader plate, said fins and said heat conducting foam are made from the same or different thermal conducting materials.

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6. A heat sink of claim 1 wherein said heat spreader plate, said fins and said heat conducting foam are made from aluminum, copper, graphite or aluminum-nitride ceramic.

7. A heat sink of claim 1 wherein said heat spreader plate, said fins and said heat conducting foam are made from aluminum.

8. A method of making a heat sink comprising a heat spreader plate, at least two fins and reticulated foam block that fills the space in-between the fins comprising,

selecting said heat spreader plate, said fins and said foam block;

assembling said fins and said foam block onto said spreader plate so that said fins are substantially parallel to one another and substantially perpendicular to said spreader plate and said foam block fill the space in between said fins; and

bonding the assembly of said fins and said foam block to said spreader plate.

9. A method of claim 8 wherein the assembly of said fins and said foam block are connected to one surface of said heat spreader plate.

10. A method of claim 8 wherein said bonding is accomplished using a thermally conductive adhesive or furnace brazing.

11. A method of claim 8 wherein the fin height, $\boldsymbol{b}$, is determined by the relationship,

$$\boldsymbol{b} = 0.6498\sqrt{\frac{k_f \delta_f}{h}}$$

where,

k_f is the thermal conductivity of the selected fin material, Btu/ft s °F

δ_f is the fin thickness, ft

h is the convective heat transfer coefficient for the foam-filled space bounded by the fins and the spreader plate, Btu/ft^2 s °F, and where h is given by the formula,

$$h = 1.2704\left[\frac{n^{0.50}}{(1-\phi)^{0.25}}\right]\left(\frac{\rho^{0.50}k^{0.63}c_p^{0.37}}{\mu^{0.13}}\right)u_m^{0.50}$$

where,

n is the linear density of the foam material, pores per ft

ϕ is the foam porosity expressed as a fraction

ρ is the density of the flowing fluid, lb_m/ft^3

k is the thermal conductivity of the flowing fluid, Btu/ft s °F

c_p is the isobaric specific heat of the flowing fluid, Btu/lb_m °F

μ is the dynamic viscosity of the flowing fluid, lb_m/ft s

u_m is the mean velocity of the flowing fluid, ft/s

12. A method of claim 8 wherein the fin spacing, ***a***, is determined by the relationship,

$$\boldsymbol{a} = \Phi\delta$$

where,

Φ is between 1 to 6

δ, ft, is determined by the relation,

$$\delta = 7.32\sqrt{\frac{kc}{\rho c_p u_m}}$$

where,

c is the selected fin length in the flow direction, ft

k is the thermal conductivity of the flowing fluid, Btu/ft s °F

ρ is the density of the flowing fluid lb_m/ft^3

c_p is the isobaric specific heat of the flowing fluid, $Btu/lb_m{}^oF$

u_m is the mean velocity of the flowing fluid, ft/s.

13. A method of claim 8 wherein said heat spreader plate, said fins and said heat conducting foam are made from the same or different thermal conducting materials.

14. A method of claim 8 wherein said heat spreader plate, said fins and said heat conducting foam are made from aluminum, copper, graphite or aluminum-nitride ceramic.

15. A method of claim 8 wherein said heat spreader plate, said fins and said heat conducting foam are made from aluminum.

16. A method of cooling electronic components by attaching the electronic components to one surface of a heat sink and passing a cooling fluid over the opposing surface of the heat sink, wherein said heat sink comprises,

a heat spreader plate,

at least two heat conducting fins that are positioned substantially parallel to one another and which are connected substantially perpendicular to said heat spreader plate, and

highly porous heat conducting reticulated foam block that fills the space between parallel fins,

wherein the height of said fins, ***b***, and is determined by the relationship,

$$\boldsymbol{b} = 0.6498\sqrt{\frac{k_f \delta_f}{h}}$$

where,

k_f is the thermal conductivity of the selected fin material, Btu/ft s °F

δ_f is the fin thickness, ft

h is the convective heat transfer coefficient for the foam-filled space bounded by the fins and the spreader plate, Btu/ft^2 s °F, and where h is given by the formula,

$$h = 1.2704\left[\frac{n^{0.50}}{(1-\phi)^{0.25}}\right]\left(\frac{\rho^{0.50} k^{0.63} c_p^{0.37}}{\mu^{0.13}}\right) u_m^{0.50}$$

where,

n is the linear density of the foam material, pores per ft

ϕ is the foam porosity expressed as a fraction

ρ is the density of the flowing fluid, lb_m/ft^3

k is the thermal conductivity of the flowing fluid, Btu/ft s °F

c_p is the isobaric specific heat of the flowing fluid, Btu/lb_m °F

μ is the dynamic viscosity of the flowing fluid, lb_m/ft s

u_m is the mean velocity of the flowing fluid, ft/s

and wherein the fin spacing, ***a***, is determined by the relationship,

$$\boldsymbol{a} = \Phi\delta$$

where,

Φ is between 1 to 6

δ, ft, is determined by the relation,

$$\delta = 7.32\sqrt{\frac{kc}{\rho c_p u_m}}$$

where,

c is the selected fin length in the flow direction, ft

k is the thermal conductivity of the flowing fluid, Btu/ft s °F

ρ is the density of the flowing fluid lb_m/ft^3

c_p is the isobaric specific heat of the flowing fluid, $Btu/lb_m{}^oF$

u_m is the mean velocity of the flowing fluid, ft/s.

17. A method of claim 16 wherein the electronic component is a microprocessor, the cooling fluid is air and the heat sink is made from aluminum materials.

18. A method of claim 17 wherein the air is drawn in from the open side walls of said foam blocks and exhausted out of the top of said foam blocks.

19. A method of claim 17 wherein the air is drawn through said foam blocks along the entire length of said parallel fins.

20. A method of claim 17 wherein the air is pushed through said foam blocks.

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